

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claims 1-6 (canceled).

Claim 7 (previously presented). A sensor for measuring water content of bulk materials, the sensor being powered by a direct current excitation, the sensor comprising:

an oscillator to provide a square wave voltage signal;

a transmission line having an input and an output, the transmission line input being coupled to receive the square wave voltage signal, the transmission line output being coupled to a phase detector;

the phase detector detecting a phase difference between the square wave voltage signal provided by the oscillator and the signal provided to the transmission line, the phase detector providing an output signal indicative of the phase difference caused by changes in moisture content of a medium surrounding the transmission line wherein the phase detector comprises:

a semiconductor circuit having first and second inputs and an output, the output of the semiconductor circuit being indicative of a logical exclusive OR function of signals applied to the first and second inputs of the semiconductor circuit, the first input of the semiconductor circuit being coupled to the oscillator to receive the square wave voltage signal and the second input of the semiconductor circuit being coupled to the transmission line;

a low pass filter providing a direct current output proportional to moisture content.

Claims 8-10 (canceled).

Claim 11 (previously presented). A sensor for measuring water content of bulk materials according to claim 7 wherein a time domain reflectometry wave form is used to measure the phase difference.

Claim 12 (previously presented). A sensor for measuring water content of bulk materials according to claim 7 wherein a frequency domain wave form is used to measure the phase difference.

Claim 13 (canceled).

Claim 14 (previously presented). A sensor for measuring water content of bulk materials according to claim 7, further comprising an insulator over the transmission line.

Claim 15 (canceled).

Claim 16 (previously presented). A sensor for measuring water content of bulk materials according to claim 7 wherein the low pass filter comprises a resistor and a capacitor connected to the output of the semiconductor circuit producing a DC voltage proportional to the phase difference of the signals provided to the first and second inputs.

Claim 17 (previously presented). A sensor for measuring water content of bulk materials according to claim 7 wherein the semiconductor circuit comprises electrical traces on an elongated printed circuit board.

Claim 18 (previously presented). A sensor for measuring water content of bulk materials according to claim 7 wherein the semiconductor circuit comprises electrical traces on an elongated printed circuit board, and wherein the electrical traces on the elongated printed circuit board sense a dielectric constant of the bulk materials based on the measured phase difference.

Claim 19 (previously presented). A sensor for measuring the water content of bulk materials comprising:

first and second elongate members, each having substantially identical shape and size so that the first and second members mate with one another and are bonded together to form a sensor;

sensor electronics mounted on the first member, the sensor electronics being protected by a housing, the sensor electronics being responsive to a direct current excitation for providing an output signal which is proportional to an amount of water present in a bulk material;

wherein the sensor electronics comprise:

an oscillator responsive to a direct current excitation, to provide a square wave signal;

a transmission line being coupled to receive the square wave voltage signal from the oscillator through a resistor, and a phase detector to detect a difference in phase between the square wave voltage signal provided by the oscillator and the signal provided to the transmission line, the phase detector being further constructed to provide an output signal indicative of the difference in phase between a square wave signal provided to the transmission line through the resistor and the response of the transmission line.

Claim 20 (previously presented). The sensor as recited in claim 19 wherein the output of the sensor electronics is proportional to a water content of the bulk material.

Claim 21 (previously presented). The sensor as recited in claim 19 wherein the phase detector comprises:

a semiconductor circuit having first and second inputs and an output, the output of the semiconductor circuit being indicative of the phase difference of the signals applied to the first and second inputs of the semiconductor circuit, the first input of the semiconductor circuit being coupled to the oscillator to receive the square wave voltage signal and the second input of the semiconductor circuit coupled to the transmission line;

a resistor and a capacitor providing a low pass filter connected to the output of the semiconductor circuit producing a DC voltage proportional to the phase difference of the signals provided to the inputs.

Claim 22 (previously presented). The sensor as recited in claim 19 where the dielectric constant of a bulk medium is sensed using a transmission line embedded in the bulk material;

the transmission line comprising traces on an elongated printed circuit board, the circuit board further comprising a semiconductor circuit.

Claim 23 (canceled).

Claim 24 (previously presented). A method of measuring moisture in a bulk material, comprising:

- providing a transmission line comprising in input and an output;
- embedding the transmission line into a bulk material
- providing a signal to the input of the transmission line;
- providing a phase detector, the phase detector being operatively coupled to the output of the transmission line and a reference signal;
- the phase detector measuring a phase difference between the reference signal and an output signal from the transmission line to determine a moisture content of the bulk material surrounding the transmission line.

Claim 25 (previously presented). The method of claim 24, further comprising:
determining the dielectric constant of the bulk material by the phase difference
to measure the moisture content of the bulk material.

Claim 26 (new). The method of claim 24, wherein the phase detector measures
the phase difference using an Exclusive OR gate.

Claim 27 (new). A sensor for measuring the water content of bulk materials,
comprising:

- a first circuit board;

- a second circuit board bonded to the first circuit board, the first and second
printed circuit boards cooperating to form a water sensor;

- sensor electronics sandwiched between the first and second circuit boards
responsive to current excitation to provide an output signal indicative of an amount of
water present in a bulk material, the sensor electronics further comprising:

- a capacitor charging rate measuring circuit, comprising:

- an oscillator to provide a wave voltage signal;

- a transmission line sandwiched between the first and second circuit
boards;

- a capacitor electrically connected to the transmission line;

- a phase detector electrically connected to the transmission line.